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The impacts of different land use changes on groundwater level using quantitative model WEAP (Case study: Chaharmahal Bakhtiari province, Iran)

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Abstract

Reduction of water resources limits the ability of farmers for food production and subsistence. Nowadays the quick growth of population has been the most important factor in the decline of renewable water. In many parts of Iran, including region of interest, the major factor in water resources decline was land use change, that may cause to ecological destruction and disruption. Sustainable development can be achieved with proper management of watersheds. This study tried to determine the effect of land use type on water resources the Chaharmahal Bakhtiari plains. TM images in May of 1982, 2000 and 2012 were used to prepare the land use maps for 8 plains. The resulted maps for 2012 were reviewed using topographical maps (1:25000) and field observations. The water level measurements during 2002 to 2012 in different plains were used for calibration and validation of WEAP model. The quantitative model used to determine the effects of land use changes on groundwater level. The extent of Agricultural land use have increased from 1982 to 2002 and 2012 from 28.8% to 35.6% and 38.7% accordingly. The results revealed that except of Farsan, Shalamzar and Gandoman the other plains have negative groundwater balance. The model simulation showed that continuing the current harvesting cause to critical situation in the near future. To compensate the negative water balance of Shahreh Kord, Borojen, Sefid dasht, Kiyar, Flared and Khan mirza, it would be necessary to reduce the consumption of groundwater resources of these plains up to %48, %32, %66, %30, %13 and %12, respectively. The change of land use from grasslands to agriculture was the main reason of reduced the groundwater reserves.

Keywords: Rangeland; Land use; WEAP models; Satellite imagery; Chaharmahal Bakhtiari

1. Introduction

Water is the most important component of natural resources and human̓s life, industry, agriculture sections. However, human being can̓t live without water but it can be a danger for health peace and welfare. Therefore, the accurate research in different aspects and effective management of water resources is necessary (Mortezaii, Shahbazi, 2012). Reduction of water resources limits the ability of farmers for food production and subsistence. Nowadays the quick growth of population has been the most important factor in the decline of renewable water. In many parts of Iran, including Region of interest, the major changes on water resources occurred due to large changes in land uses; it can cause to eco logical destruction and disruption. Sustainable development can be achieved with proper management of watersheds. (Dehkordi, 2014).

There is a primary study on Chessmeh Ali area of Chaharmahal Bakhtiari province in Iran, which is used as the initial information for the research. According to this information there are four different land uses including approximately good pasture (> 20%), poor pasture (< 10%), dry land farms and abandoned dry land farms. Soil samples were collected from depth of 0-10 cm in a completely randomized block design with four replications. The data analysis showed

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that the contents of soil organic matters and available phosphorus decreased during land use change in rangeland and maximum decrease was observed in rain fed cultivated land (50% and 68.8%, respectively). In general it can be said that land use change from natural land like rangeland to other land uses tends to reduce the soil quality and soil surface becomes sensitive to erosion (Yousefifard, 2007).

Over the past years and for several reasons such as excessive and irrational exploitation of water resources, particularly groundwater, causing problems such as drought and disregard of conservation principles in water resources utilization, some of water resources in Iran were destroyed or are at risk of destroy. This allocated to agriculture more than 90 % of Iranian consumptive water volume, causes more critical conditions, and the element of water has been transferred to one of the most important limiting for water resources (Ahankob, 2013).

Most of the effects of natural areas management is on the basis human activities. The impacts of land use change reflect human effects. Also land use as a central part of the earth, systems function a little raises complete, interactions of humans and environment at local to global scales (Guner *et al.*, 2010, Abusaada, 2011). According to the study of demand management effects partially, in agriculture sector in south of Africa"olyqan River" watershed model WEAP In one of the sub stain of this river named "Steel port “By this software showed that in some parts of the basin, in cannot be provided with WEAP software rapid assessment of decisions for water allocation suitable. But hydrological cannot model drastic changes of South Africa (Levite *et al.*, 2003). Collaboration with communities for creating new and sustainable ways to reduce pressure on the land in arid and marginal desert areas can be a powerful tool to overcome poverty and struggle desertification and its resiliency (Kavandi *et al.*, 2014).

Gunkel, Lange, (2012) studied new insights into the natural variability of water resources in the Lower Jordan River Basin and three rainfall seasons are simulated: a drought, an average season and a wet extreme. Simulation results emphasize the non-linear behavior of (semi-) arid systems and resulting impacts on the spatial and temporal variability of water resources. Basin averages of seasonal water balance components ranged between 65 and 489 mm (rainfall), 53 and 270 mm (evapotranspiration), 7 and 87 mm (overland flow), 4 and 129 mm (percolation). Bonzi *et al.*, (2016) analyzed stakeholder driven scenarios with a trans boundary water planning tool for IWRM in the Jordan River basin. These scenarios suggested that the positive effects of large scale water management options such as the increased use of treated wastewater and sea water desalination can be strongly limited by insufficient water transport infrastructure and a lack of cooperation.

The main objectives of this study are as follow:
1: Determine the land use changes in the study period (From May 1982 to May 2012) and projected future changes (in three periods of at least 30 years)
2: Using WEAP quantitative model towards land use planning related to groundwater resources so determined to prevent instability over natural resources.

2. Materials and Methods

2.1. The study area

Chaharmahal Bakhtiari province, is one of the 31 provinces of Iran, geographical coordinates 31°9' - 32°48' north latitude and east of the central Zagros 51° 25' - 49°28' and along the Zagros fold and thrust belt is situated (Figure1). The Province is located in west center of the country and Share Kurd is its capital. The province is divided to five Counties includes Ardle, Borojen, Share Kurd, Farsan, and Ardakan. Chaharmahal Bakhtiari province, consist of two parts first, Chaharmahal means (4 cities), of Lar, Kiyar, Mizoj, and Gandoman, the second part Bakhtiari where Bakhtiari Tribe lives and named after the Tribe, this tribe historically is a branch of Great Lur Trib used to move between two states of Khuzestan and Shiraz. The state has mild semi dry climate, colourful and charming nature with high mountains and slopes covered with flowers, ponds, lakes, lagoons, and water streams.

Shahreh Kord with an area of 294212 hectares enjoys a cold semi-arid climate, with hot summer days, mild summer nights, cool winter days and cold winter nights. The annual average temperature in Shahreh Kord is about 5.1°C but the minimum and maximum absolute temperatures recorded in Shahreh Kord during the last 30 years have been -32°C and 42°C, respectively. December is the coldest month and July is the hottest month. Although the humidity level is moderate or high in winter, the amount of rainfall is close to zero in planting seasons, except for April and May.

Lord Egan county with an area of 342110 hectares is a county in Chaharmahal-o-Bakhtiari Province in Iran. The capital of the county is Lord Egan. At the 2006 census, the county's population was 175,289 in 34,603 families. The county contains four districts: the Central District, Manj District, Flared District, and Khan mirza District. The county has three cities: Lord Egan, Mal-e Khalifeh, and Aluni.

Ardle has a mild semi cold -arid climate. The annual average temperature in Ardle is about 11°C but the minimum and maximum absolute temperatures recorded in Ardle during the last 30 years have been -7°C and 35°C, respectively. The amount of rainfall is close to 500mm.

Farsan with an area of 55922 ha has a semi humid climate. The annual average temperature in Farsan is about 12.1°C but the minimum and maximum absolute temperatures recorded in Farsan during the last 30 years have been -6°C and 36°C, respectively. The amount of rainfall is close to 600 mm.

Borojen with an area of 251300 hectares has a semi humid climate. The annual average temperature in Borojen is about 4°C but the minimum and maximum absolute temperatures recorded in Borojen during the last 30 years have been -36°C and 36°C, respectively. The amount of rainfall is close to 360mm.

Flared District or Flared District is a district in Lord Egan County, Chaharmahal and Bakhtiari Province, Iran. The District has one city: Mal-e Khalifeh. The District has two rural districts: Flared Rural District and Poshtkuh Rural District.

Khan mirza with an area of 102300 hectares has a semi humid climate. The height of this area is 1880 of sea level. The annual average temperature in Khan mirza is about 12°C but the minimum and maximum absolute temperatures recorded in Khan mirza during the last 30 years have been 5°C and 30°C, respectively. The amount of rainfall is close to 500mm. (Figure1).

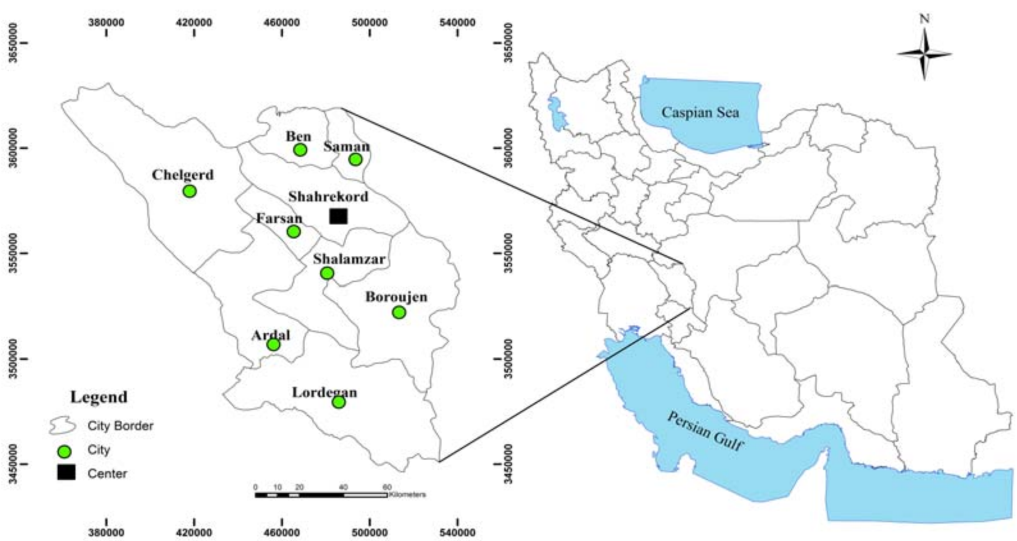

Fig. 1. The study area in Chaharmahal Bakhtiari province

2.2. Methodology Description

This study tries to determine the effect of land use on water resources in Chaharmahal Bakhtiari plains. TM images in May of 1982, 2000 and 2012 were used to prepare the land use maps for plains (Farsan, Gandoman, Shalamzar, Kiyar, Khanmirza, Borojen ,Sefid dasht and Shahreh Kord). The resulted maps for 2012 were reviewed using topographical map (1:25000) and field observations. The water level measurements during 2002 to 2012 in different plains were used for calibration and validation of WEAP model. The quantitative model used to determine the effects of land use changes on groundwater storage.

The information in this study is an important part of understanding has been collected through field studies. Hence the surveys, most of the reasons for some of the research questions were answered and a lot of discipline and understanding between the User and water resources in the region were used. In this study, using the model WEAP during the period, according to current usage, predict future changes are also possible.

2.2.1. Groundwater-surface water interaction

According to the model WEAP, to collect the information needed plains of Chaharmahal Bakhtiari level model is needed. (Yates *et al.*, 2005).

When an alluvial aquifer is introduced into the model, the second storage term is dropped and recharge for the sub catchment, R (Vol/time) to the aquifer is simply, (Table 1):

$$R = \sum_{j=1}^{N} A_j (f_j k_j z_{1,j}^2) \quad (1)$$

Where A_j is the aquifer depth (m) at equilibrium, K_j (m/time) is an estimate of the saturated hydraulic conductivity of the aquifer Surface water and groundwater are dynamically linked, Z_j is the aquifer depth (m) at equilibrium for when groundwater is depleted, a stream contributes to aquifer recharge (a losing stream), while a stream is considered to be gaining when there is substantial recharge to the aquifer across the watershed and flow is from the aquifer to the stream (Yates *et al.*, 2005).

Irrigated agriculture can complicate the picture even further, since water can be drawn from the stream, pumped from the local aquifer, or even imported from outside the basin, and thus both depletes and recharges the aquifer (Liang *et al.*, 2003; Winter, 2001, Abusaada, 2011).

Capturing these dynamics is important, and the groundwater model implemented in WEAP allows for the dynamic transfer of water between the stream and the aquifer (Figure 2). In WEAP, the aquifer is a stylized wedge that is assumed symmetric about the river, with total aquifer storage estimated under the assumption that the groundwater table is in equilibrium with the river. Thus the equilibrium storage for one side of the wedge, GSe is given as, (Yates *et al.*, 2005).

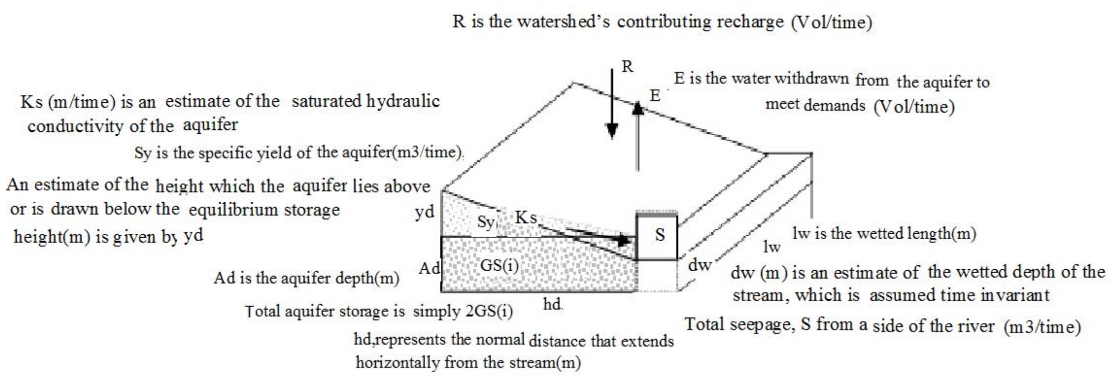

Fig. 2. Schematic of the stylized groundwater system, and its associated variables Shahreh Kord

2.2.2. Storage Capacity

The maximum amount of water that a free table can hold water.

$$GS_e = h_d * l_w * A_d * S_y \quad (2)$$

Where, h_d,represents the normal distance that extends horizontally from the stream(m), l_w is the wetted length(m) of the aquifer in contact with the stream, S_y is the specific yield of the aquifer(m3/time), and Ad is the aquifer depth(m) at equilibrium. An estimate of the height which the aquifer lies above or is drawn below the equilibrium storage height(m) is given by y_d., so the initial storage GS in the aquifer at t=0, is given as,

$$GS(0) = GS_e + (y_d * h_d * l_w * S_y) \quad (3)$$

Initial Storage: The amount of storage in the aquifer simulation this parameter has a surface area, the average saving rate and depth of water in the aquifer is obtained. The amount of storage in the aquifer simulation this parameter has a surface area, the average saving rate and depth of water in the aquifer is obtained (Table1).

The vertical height of the aquifer above or below the equilibrium position is given as,

$$y_d = \frac{GS - GS_e}{(h_d * l_w * S_y)} \quad (4)$$

And the more the aquifer rises relative to the stream channel, the greater the seepage back to the stream and vice versa, where total seepage, S from a side of the river (m^3/time) is defined by,

$$S = (K_s * \frac{y_d}{h_d}) * l_w * d_w \quad (5)$$

Where Ks (m/time) is an estimate of the saturated hydraulic conductivity of the aquifer, and d_w (m) is an estimate of the wetted depth of the stream, which is assumed time invariant. (Yates *et al.*, 2005).

Natural recharge: The water in an aquifer on a monthly basis. This factor is multiplied by the surface area and penetration of monthly precipitation will be obtained (Table1).

The wetted depth, together with the wetted length, approximates the area through which river-groundwater exchanges can take place, and the saturated hydraulic conductivity controls the rate at which water moves towards or away from this area. Once seepage is estimated, then half of the aquifer's total storage for the current time step is given as,

$$GS(i) = GS(i-1) + (1/2\,R - 1/2\,E - S) \quad (6)$$

3. Results

3.1. Withdrawals from the aquifer

The amount of monthly withdrawals from wells in the aquifer level having engine clocks in million cubic meters can be achieved (Table1).

where E is the water withdrawn from the aquifer to meet demands (Vol/time) , and R is the watershed's contributing recharge (Vol/time) (Eq. 1), and total aquifer storage is simply 2GS(i) (Table1).

To analysis and compare data can be integrated and systematic planning for sustainable land and to have a good operational strategies to suit the environmental conditions of the region. And model WEAP For other places with similar climatic conditions offered (Levite *et al.*, 2003). Analysis of satellite imagery in the study period (since May of 1982 until May of 2012).

Table 1. View the best calibration model for each plain (since May of 1982 until May of 2012)

Row	Plain Name	The mean absolute error of Model (%)	Average harvest (MCM)	Proportion of rainfall to aquifer recharge	The volume of aquifer (MCM)	Remember Aquifer (MCM)
1	Shahreh Kord	5.5	195	%25	1316	1598
2	Brojen-Fradnbeh	6.2	26	%13	218	358
3	Sefidasht	8	42	%18	93	172
4	Kiyar Sharghi	4.8	36	%17	190	191
5	Kiyar	7.6	15	%8	82	93
6	Farsan-Jong an	2.7	37	%27	72	88
7	Gandoman	11.7	43	%10	162	223
8	Javanmardi (Khan mirza)	8	97	%34	164	214
9	Flared (Mal Khalifeh)	8.5	8	%22	38	69

3.2. Changes in land use model WEAP

Analysis of changes in water resources development in relation to land use change.

Scenario 1: no change in the perception of groundwater (wells) during the simulation (the previous harvest).

Scenario 2: reduce withdrawals from groundwater (wells) during simulation scenarios 10, 20, 30 percent decrease compared to the past This scenario assumes efficiency surface irrigation and by changing land irrigation in the plains of traditional pressure was considered (Figures 3 & 4).

Scenario 3: Withdrawal of groundwater (wells) during simulation scenarios 10, 20, and 30 percent from last It is worth noting, scenario 2 for the plains that were lost during storage calibration was performed and the results of Scenario 3 to the plains that have fixed or positive carried out. The results of the implementation of the various scenarios as examples for some plains below mentioned.

Study of satellite images and topographic maps of 1: 25,000 and groundwater resources data as well as data from field studies) the change of land use from Rangeland to agriculture) in both primary and supplementary studies done in this area and include data collection and use of comparative, descriptive and analytic.

Library studies in the field of information on the range of studies, Field visits, data collection and documentation of organizations and research centers and the use of internal and external sites scientific information (Table1).

The best calibration model obtained for plain error the following table. In the simulation results are also plains in the water for some of the best calibration, is shown (Table 1).

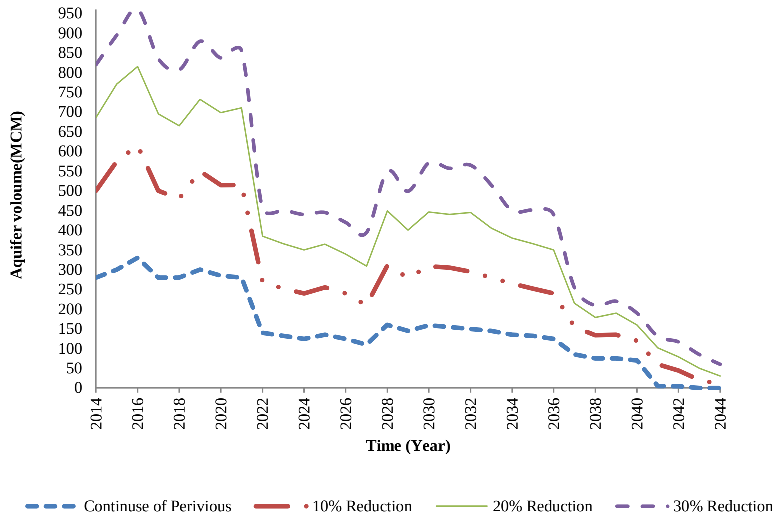

Fig. 3. WEAP outputs in different scenarios in Borojen

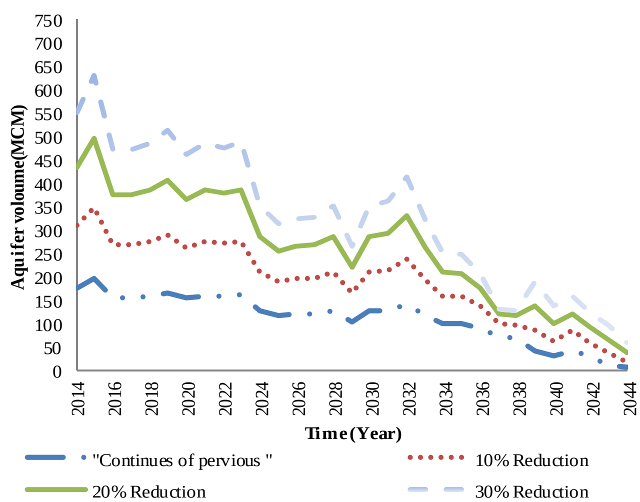

Fig. 4. WEAP outputs in different scenarios in Khan mirza

3.3. Water resources model

After calculating and determining the necessary parameters need to be calibrated model in this study for the period (2002-2012). The statistics of the plains were available in this course.. The calibration model WEAP by changing the parameters such as Storage Capacity, Initial Storage, Withdrawals from the aquifer and Natural recharge (Alizadeh, 2007).

The calibration of the groundwater aquifer volume observed for each month during the simulation and comparison with the observation that the size of the water level in the aquifer is obtained each month from piezometers.

After running the model and comparing the calculated groundwater level observed with calibration during the 10 years (2002-2012) to be calibrated in such a way that these errors are of an acceptable level (e.g. 10%), not more (Figures 5 & 6).

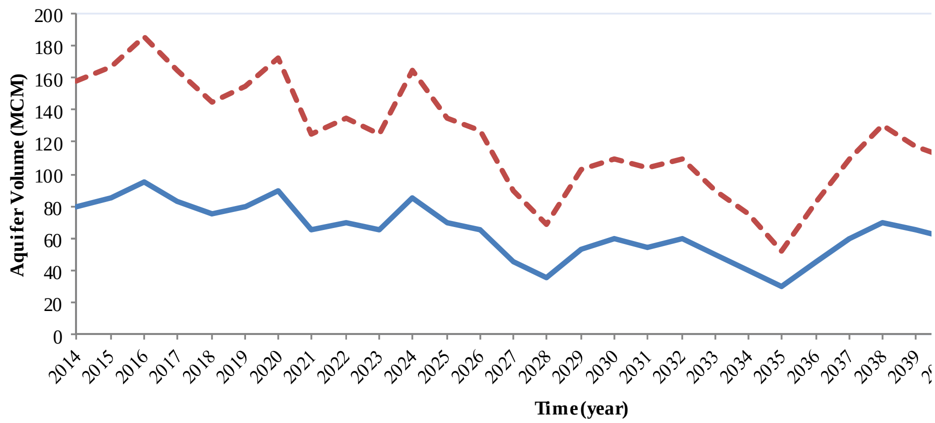

Fig. 5. Comparison of the output and field observations Shahreh Kord

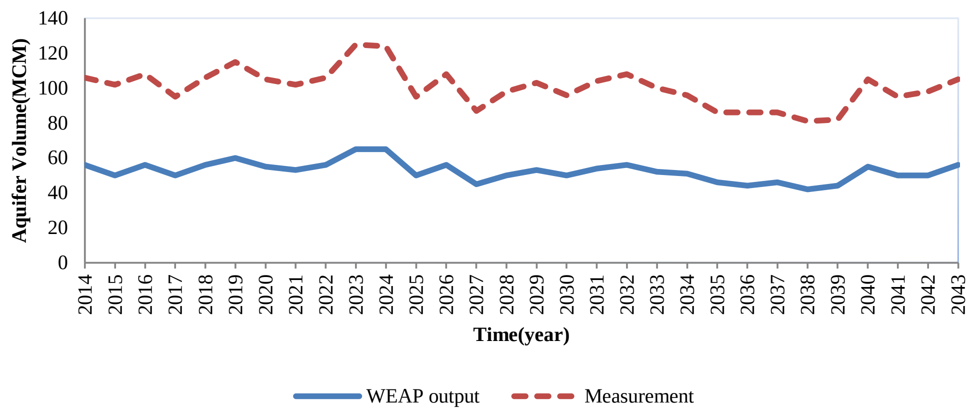

Fig. 6. Comparison of the output and field observations Flared

Agricultural lands significantly changed during the study period; in 1982, 2002 and 2012 it covers 28.8%, 35.6% and 38.7% of all areas respectively. The results revealed that except of Farsan, Shalamzar and Gandoman the other plains have negative groundwater balance.

The sustainability of natural resources directly or indirectly associated with the surface of the land area to maintain harmony between sustainable resources and socio-economic needs require study on the cover and land uses.The results of the assessments of groundwater resources in Chaharmahal Bakhtiari plain WEAP model shows that with the exception of plains Farsan, Shalamzar and other wheat plains of the province are faced with a negative balance.

After calibration of the model, the analysis was performed for a 30 years period from 2014 to 2044. In this connection, the following scenarios were considered for the assessment of water resources. These results have also been obtained for other plains which are summarized in the following table are listed (Table 2).

Table 2. The results of the reduced harvest in different regions to achieve a balance

Row	Plain Name	Storage after 30 years in the form of reduced exploitation (MCM)	Percent reduction in exploitation to achieve a balance (%)	Primary storage (MCM)
1	Shahreh Kord	57	48	1311
2	Brojen-Fradnbeh	7	32	217
3	Sefidasht	9	66	92
4	Kiyar Sharghi	17	30	188
5	Javanmardi	33	12	460
6	Flared (Mal Khalifeh)	5	12	36

4. Discussion and Conclusion

One of the most important water resources problems in Iran is over utilization of groundwater resources. one of the best useful ways to manage and control the aquifers is modeling. in this paper we have tried to assess the groundwater resources of Chaharmahal in the future, with modeling of surface and groundwater together in various scenarios using WEAP model.

The model simulation shows that continuing the current harvesting cause to critical situation in the near future. To compensation the negative balance of Shahreh Kord, Borojen, Sefiddasht, Kiyar, Farad and Khan mirza, it would be necessary to reduce the consumption of groundwater resources of these plains up to %48, %32, %66, %30, %13 and %12, respectively. The main reason for the change of land use from grasslands to agriculture, was reduced the groundwater reserves.

Another important point is the role of social, economic and political. Related data clearly not available while soil factors, geology were involved in the analysis of the model were considered. The results of this study are in well agreement with that of other studies, e.g. Alfarra, (2004). The river basin of Lake Naivasha in Kenya researcher on using the software WEAP to find the causes and future problems that the study showed:

1. The main problem is related to the agricultural sector so that in some parts over the allocation of irrigation water is needed. While on the contrary, in other areas of need does not provide.
2. In fact, the main problem in the management of non-normative, not a little water.
3. The main reason for the change of land use from Rangeland to agriculture has been reduced groundwater reserves.

The demand for different sectors in the coming years, the river's watershed is faced with numerous problems. Poor performance of state organs, causing damage to land in their areas of study. This is due to legal deficiencies users of all government agencies in receipt of wells used. To capture the most important areas of natural resources. Changes in the destruction of the land, however small, will affect their role.

Effective IWRM models must address the two distinct systems that shape the water management landscape. Factors related to the bio-physical system, namely climate, topography, land cover, surface water hydrology, groundwater hydrology, soils, water quality, and ecosystems shape the availability of water and its movement through a watershed. Factors related to the socio-economic management system, driven largely by human demand for water, shape how available water is stored, allocated, and delivered within or across watershed boundaries. Increasingly operational objectives for the installed hydraulic infrastructure constructed as part of the management system seek to balance water for human use and water for environmental needs (Biswas, 1981; Jamieson, 1986; Bower, 2000; Zalewski, 2002; Westphalia *et al.*, 2003; Lange *et al.*, 2012b).

The advancements of WEAP21 have been based on the premise that at the most basic level, water supply is defined by the amount of precipitation that falls on a watershed or a series of watersheds with this supply progressively depleted through natural watershed processes, human demands and interventions, or enhanced through watershed accretions. Thus, WEAP21 adopts a broad definition of water demand, where the watershed itself is The first point of depletion through evapotranspiration via surface-atmosphere interactions (Mahmoud and Hubbard, 2002; Lange *et al.*, 2012a,).

The construction of drainage channels in the middle of the study area in order to drain out the water creates a sense of ownership of lands in areas adjacent to agricultural land eventually destruction of nearby drainage in 20 years is causing damage to a lot of pasture land. The main reason for the change of land use from grasslands to agriculture, was reduced the groundwater reserves.

References

Abusaada, M.J., 2011. Flow dynamics and management options in stressed carbonate aquifer system, the Western Aquifer Basin, Palestine.

Ahankob, A., 2013. Check the water crisis in the aquifer Khanmirza (Chaharmahal Bakhtiari). The first National Conference on Water Crisis. Islamic Azad University, Isfahan, The International Journal of Engineering and Science, 2; 53-59.

Alfarra, A., 2004. Modeling water resource management in Lake Naivasha. International Institute for Geo Information Science and Earth Observation Enchased 24-25.

Alizadeh, H., 2007. Assess the impact of the allocation of water in the basin hydrological scenarios using software WEAP. Hydro Sci Techno., 23; 1-12.

Biswas, A.k., 1981. Integrated water management; Some international dimensions. Journal of Hydrology, 51; 369-379.

Bonzi, C., J. Onigkeit, H. Hoff, 2016. Analysing stakeholder driven scenarios with a trans boundary water planning tool for IWRM in the Jordan River Basin. In: Borchardt D, Bogardi J, Ibisch R (eds) Integrated water resources management; concept, research and implementation. Springer, Berlin.

Bower, H., 2000. Integrated water management; Emerging issues and challenges. Agricultural water Management, 45; 217-228.

Dehkordi, F., 2014. The effect of slope and land use changes on soil microbial respiration indices in the region. Chaharmahal Bakhtiari Lord Egan. Journal of Soil Management, 2; 13-25.

Guner, S., A. Tufekcioglu, S. Gulenay, M. Kucuk, 2010. Land use type and slope position effects on soil respiration in black locust plantations in artvin, Turkey. Journal Agricultural Research, 5; 719-7.

Gunkel, A., J. Lange, 2012. New insights into the natural variability of water resources in the Lower Jordan River Basin. Water Resour Manage., 26: 963–980.

Kavandi, H.R., C.H. Heshmati, H. Serous, 2014. Evaluation of Alternative Livelihoods Status in Arid and Semiarid Regions of Iran to Improve Sustainability. Journal of Rangeland Science, 4; 306-318.

Lange, J., A. Gunkel, D. Bastian, 2012a. Hydrology in the lower Jordan River basin. About actual water resources and new water resources—an analysis based on the TRAIN-ZIN model. Jordan River Final Conference Limassol, Cyprus.

Lange, J., S. Husary, A. Gunkel, 2012b. Potentials and limits of urban rainwater harvesting in the Middle East. Hydro. Earth Syst. Sci., 16: 715–724.

Levite, H., H. Sally, J. Cour, 2003. Testing water demand management scenarios in water- stressed Basin in south Africa: Application of the water WEAP model, Julian Cour. International Water Physics and Chemistry of the Earth, 28; 779–786.

Liang, X., Z. Xie, M. Huang, 2003. A new parameterization for surface and groundwater interactions and its impact on water budgets with the variable infiltration capacity (VIC) land surface model. Journal of Geophysical Research, 108(D16); 1-8.

Mahmoud, R., K. Hubbard, 2002. Anthropogenic land-use changes in the North American tall grass-short grass transition and modification of near-surface hydrologic cycle. Climate Research, 21; 83-90.

Mortezaii, F. G., R. Shahbazi, 2012. Survey indicators for assessing and mapping water and wind erosion desertification and provide sustainable development strategy. Journal of Watershed Management Engineering Association Iran, 6; 45-52.

Westphalia, K., R. Vogel, P. Kirsten, 2003. Decision support system for adaptive water supply management. Journal of Water Resources Planning and Management, 129; 165-177.

Winter, T., 2001. Ground water and surface water: the linkage tightens, but challenges remain. Hydrological Processes, 15; 3605-3606.

Yates, D., J. Sieber, D. Purkey, A. HuberLee, 2005. WEAP21– A Demand, Priority, and Preference Driven Water Planning Model. WRA, Water International, 30; 487-500.

Yousefifard, M., 2007. Degradation of soil quality, land use pasture area during the spring Ali Chaharmahal Bakhtiari province. Journal of Science Technology Agriculture Natural Resources, 11; 93-106.

Zalewski, M., 2002. Eco hydrology- the use of ecological and hydrological processes for sustainable management of water resources. Hydrological Sciences Journal, 47; 823.